

Probing Magnetic Anisotropy in Frustrated Magnets with High-Field Torque Magnetometry

Magnetic torque magnetometry is a powerful probe of magnetic anisotropy, sensitively detecting field-induced transitions in small single crystals of novel materials at high magnetic fields. We apply torque magnetometry as a function of magnetic field orientation to a variety of frustrated magnets that span contrasting lattices and ground states. Firstly, we investigate the metallic triangular delafossite 2H-AgNiO_2 , which hosts localized $S=1$ moments. Under applied fields up to 45 T, a series of magnetic transitions are detected from a collinear antiferromagnetic state to proposed magnetic supersolid orders, where translational and spin rotational symmetries are broken [1]. Close to the first supersolid phase boundary, the torque signal exhibits a sawtooth angular dependence, while near the Néel temperature an unexpected additional modulation emerges [2]. We find that the observed behaviours can be understood through semiclassical calculations of an easy-axis triangular Heisenberg model [2]. Additionally, we investigate the Kitaev honeycombs $\alpha\text{-RuBr}_3$, which stabilises zigzag antiferromagnetic order below 34 K [3], and the isoelectronic $\alpha\text{-RuI}_3$, where no long-range magnetic order is stabilised [4]. Torque reveals easy-plane anisotropy in $\alpha\text{-RuBr}_3$ and a change of sign with temperature in $\alpha\text{-RuI}_3$ that marks a crossover from easy-axis to easy-plane anisotropy, with a sixfold symmetry in the honeycomb plane reflecting bond-dependent interactions. In high fields up to 55 T, the torque of $\alpha\text{-RuBr}_3$ follows the expected parabolic field dependence, whereas $\alpha\text{-RuI}_3$ develops a broad kink at a characteristic crossover field. These studies highlight torque magnetometry as a versatile probe of both phase transitions and magnetic anisotropies in novel frustrated quantum materials.

[1] A. I. Coldea et al., Phys. Rev. B 90, 020401(R) (2014).

[2] J. Pearce et al., in preparation (2026).

[3] J. Pearce et al., Phys. Rev. B 110, 214404 (2024).

[4] Z. Ma et al., Communications Physics, 7, 390 (2024).